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Gamification in Flipped Classrooms for Sustainable Digital Education: The Influence of Competitive and Cooperative Gamification on Learning Outcomes

Mada Bandar Alshiha and Ahlam Mohammed Al-Abdullatif *

Department of Curriculum and Instruction, King Faisal University, Al-Hasa 31982, Saudi Arabia; 221512206@student.kfu.edu.sa
* Correspondence: aalabdullateef@kfu.edu.sa

Abstract: This study examines the effects of competitive versus cooperative gamification mechanics on the learning achievement of female first-year middle school students in flipped classrooms, highlighting its implications for designing sustainable learning environments. Employing a quasi-experimental design, 60 students were randomly assigned to two experimental groups, each engaged in a flipped classroom environment with either competitive or cooperative gamified elements. While both groups showed significant improvement in post-test scores, no significant differences were observed in cognitive achievement or skills acquisition between the groups. These findings emphasize that competitive and cooperative gamification mechanics can be equally effective in enhancing learning, suggesting that the choice of mechanic does not critically impact learning outcomes. The study provides practical guidance for educators and instructional designers in developing balanced gamified learning environments that optimize competitive and cooperative strategies, thus fostering a more versatile and adaptable approach to student motivation and engagement in sustainable technology-enhanced education.

Keywords: gamification; flipped learning; achievement; sustainable learning

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1. Introduction

The advancement of information and communication technologies has transformed education, necessitating the adoption of digital tools to meet the needs of today's digitally immersed learners. E-learning platforms have become essential tools in modern education. They offer interactive and personalized learning experiences that adapt to each student's unique needs and learning styles. These platforms provide interactive and personalized experiences, catering to diverse learner needs and preferences. By incorporating models like flipped classrooms and gamification, they not only enhance student engagement but also drive motivation and improve academic outcomes [1,2]. The flipped classroom model is an integrative approach that combines classroom learning with e-learning. This modern educational approach has proven highly effective in the educational process [3]. The flipped classroom model transforms traditional education by restructuring the learning process to maximize engagement and collaboration. Educational content is delivered at home through digital platforms, allowing learners to explore materials such as videos and readings before class. This approach frees up classroom time for interactive activities, group tasks, and in-depth discussions, fostering a more hands-on and engaging learning environment. By integrating electronic learning tools, the flipped classroom effectively shifts content delivery to pre-class preparation while prioritizing practical application and collaboration during class sessions [4,5]. Many studies have confirmed that the flipped classroom model requires the use of gamified learning activities to make the learning process continuous and active, thereby enhancing participation and social interaction and making learning enjoyable and intriguing [6].

Gamification is a new approach to encouraging and motivating learners to learn in e-learning environments. Prakash and Rao [7] define gamification as the use of game elements and mechanics in non-play contexts to engage learners and encourage them to achieve learning goals with the utmost enjoyment and engagement. Gamification consists of a set of elements, which is what distinguishes digital games, drives learners to play, and influences their behavior by creating excitement, enjoyment, and engagement [8]. According to Werbach and Hunter [9], gamification elements are the small parts that comprise a game's structure or environment, of which there are three types: dynamics, mechanics, and components. Dynamics are the underlying aspects that shape the overall experience without directly being part of the game elements, such as emotions, narrative, and relationships. Mechanics are the core processes that drive learners to play and interact with the content, thus generating learner engagement and maintaining continuous interaction. Components are the actual tools used to build the game system; they are specific instances of mechanics, such as levels, points, and rankings.

Many studies have pointed to the impact of gamification on learning outcomes, the model's effectiveness in developing various skills, and its ability to motivate learners and stimulate their participation and interaction in the learning process [10,11]. Despite the abundant results of studies on gamification in general and its positive impact on learning outcomes, few studies have addressed how different gamification mechanics affect the learning process [12]. These studies also added that gamification studies should not be limited to verifying the effectiveness of common gamification features, such as points, badges, and leaderboards, but should also be extended to the key design mechanics of these incentives, such as competitive and cooperative gamification mechanics. The authors recommended conducting further research to verify the effectiveness of competitive and cooperative gamification mechanics in different learning environments.

Gamification mechanics are one of the elements of digital gamification. Mousa [13] defined such mechanics as the core processes that drive people to interact with a game and motivate them to continue participating in it, including competition, cooperation, and challenges. Competition is among the most essential elements necessary to build a gamification system [12]. Competition is among the most common and widely used elements in educational digital gamification systems [14,15]. Competitive gamification mechanics center on rivalry, individual achievement, and outperforming others. Participants are pitted against each other, often to be the best or achieve the highest score [6]. The primary objective is individual success, with each participant aiming to outperform the others to earn rewards or recognition [16]. Several studies have emphasized the importance of competitive gamification mechanics in the learning process. Such mechanics encourage interaction, achievement, and goal attainment [17]; they also lead to increased social motivation and higher levels of learner participation [18]. Competitive gamification mechanics contribute to positive changes in learner behavior and are an effective educational tool for enhancing learner self-efficacy [19].

Cooperative gamification is another essential component of building a gamification system [12]. Cooperative gamification mechanics center on collaboration, teamwork, and collective problem-solving. Participants work together towards a common goal, sharing resources, knowledge, and strategies [6]. The primary objective is often to achieve a group goal, where success depends on the collective efforts of all members. In this setting, learners collaborate with their group members, sharing experiences and skills to achieve goals and earn the best rewards as a group [20,21]. Multiple studies have underscored the significance of cooperative gamification mechanics in the educational process. Such mechanics play a key role in facilitating communication and knowledge sharing, strengthening social ties among learners, and driving them to pursue shared goals [15]. These mechanics also support the exchange of ideas, opinions, and information, all of which enhance positive interactions among learners. This approach fosters greater participation in educational activities and increases students' motivation to achieve goals and objectives [22].

Several studies have underscored the need to delve deeper into the dynamics of gamification mechanics. For instance, Jagust et al. [23] and Engelhardt and Elbæk [24] emphasized the importance of understanding the effectiveness and interactions involved in various gamification mechanics, particularly cooperative and competitive types. Similarly, Morschheuser et al. [12] identified a significant gap in the literature concerning direct comparisons between different gamification mechanics, particularly competition and cooperation, which are often deployed without sufficient empirical validation of their distinct impacts.

This gap becomes even more pronounced in the context of flipped classrooms, a pedagogical approach that combines pre-class independent learning with in-class active engagement. While flipped classrooms have been shown to improve learning outcomes, their synergy with specific gamification strategies has received limited attention. Current research does not adequately address how competitive and cooperative gamification mechanics function within flipped classrooms or their relative effectiveness in enhancing learning performance across cognitive and skills-based dimensions. This study thus aims to investigate and compare the effectiveness of competitive and cooperative gamification mechanics within a flipped classroom, focusing on their influence on enhancing learning performance, specifically its cognitive and skills aspects.

The findings aim to extend the body of knowledge on gamification by offering empirical evidence of the strengths and limitations of competitive and cooperative mechanics. Moreover, this research contributes to the growing field of flipped classroom pedagogy by demonstrating how gamification can enhance its effectiveness. The ultimate goal is to provide educators and instructional designers with actionable insights into the optimal use of gamification mechanics in blended learning environments, thereby supporting more engaging, equitable, and effective educational practices. By addressing these gaps, this study seeks to bridge the divide between theory and practice, offering a practical contribution to the design of gamified learning environments while advancing the academic discourse on flipped classrooms and gamification.

2. Related Work on Gamification and Flipped Learning

A significant body of research has underscored the effectiveness of integrating gamification into flipped classrooms to enhance educational experiences. Sanchez et al. [25] conducted a study on the combination of gamification with the flipped classroom model in a high school Spanish literature and language course. Their findings revealed that incorporating gamification led to notable improvements in various academic indicators. In a similar vein, Ng and Lo [26] investigated the impact of gamification in flipped classrooms on sustainable learning, with a particular focus on learner achievement and engagement. The results demonstrated that a flipped classroom model enhanced by gamification significantly boosted student engagement, self-motivation, and the satisfaction of psychological needs, such as autonomy, competence, and social relatedness. Further supporting the positive effects of gamification in flipped classrooms, Al-Shahri and Al-Hafithi [2] explored the role of gamification in developing creative thinking skills among secondary school students in a computer and information technology course. Their findings revealed that the group exposed to gamification outperformed the control group in terms of creative thinking skills, thus underscoring the efficacy of gamification not only in enhancing cognitive outcomes but also in stimulating higher-order thinking skills. Additionally, Al-Harithi [27] designed a flipped classroom model based on gamification and measured its effectiveness in enhancing metacognitive thinking among preparatory-year students. The results indicated that the gamified flipped classroom significantly improved metacognitive skills, further affirming the potential of gamification to enrich various cognitive processes during learning.

More recent studies also support the benefits of gamification in education. Daliranfirouz et al. [28] found that a gamified flipped classroom significantly improved learners' performance in grammar, vocabulary, and reading comprehension, while students also perceived the approach as fun and collaborative despite the extra workload. Similarly, Balci and Esgi [29] showed that sixth-grade students in a gamified flipped classroom outperformed their peers in a traditional setting when learning algorithms, though some challenges, such as technological infrastructure, were noted. Lopes et al. [30] extended these findings by incorporating team-based learning into a flipped classroom, further optimizing student collaboration and highlighting the students' positive perceptions of this active learning approach. Zeybek and Saygı [31] and Hong et al. [32] conducted systematic reviews, with the former identifying the usefulness of gamification across various educational contexts and the latter emphasizing the need for tailored approaches using game elements such as rewards to enhance digital learning environments. Dehghanzadeh et al. [11] focused on K–12 education and proposed a framework for developing gamified learning environments that effectively improve learning experiences. Collectively, these studies demonstrate the effectiveness of gamification in flipped classrooms while also recognizing the need to address challenges such as technological limitations and workload management for both teachers and students.

While previous studies have explored the integration of gamification with flipped classrooms, this study uniquely focuses on the comparative analysis of two specific gamification mechanics: competitive and cooperative. By directly contrasting competitive and cooperative gamification, this study fills a crucial gap in understanding how these different approaches affect learning outcomes, particularly in cognitive and skills development. It also emphasizes the dual impact of gamification mechanics on both the cognitive and skills aspects of learning performance. While previous studies have highlighted cognitive improvements or engagement metrics, this study's detailed examination of both aspects provides a more comprehensive understanding of how these mechanics affect different facets of learning. This holistic approach ensures that the outcomes of future research can inform more effective pedagogical strategies that cater to both the mental and practical learning needs of students.

In the context of this research, learning refers to the acquisition of both cognitive and practical skills through active engagement in educational activities, particularly within gamified flipped classroom settings. While 'learning' can be understood from various theoretical perspectives, such as behaviorism or cognitivism, this study aligns with a constructivist view. Constructivism, as theorized by Vygotsky [33], posits that learning is an active, constructive process in which students build their understanding and knowledge of the world through experiences and reflection. This approach is particularly relevant in student-centered pedagogies such as flipped classrooms, where knowledge is actively constructed through meaningful interaction and collaboration rather than passively received.

Given the focus of this study on comparing cooperative and competitive mechanics within a gamified environment, learning refers to both cognitive skills (e.g., comprehension, analysis, and the application of knowledge) and practical skills (e.g., the ability to perform tasks). These skills are developed using gamified mechanics (competition or cooperation) that motivate students to actively participate in their learning process. The flipped classroom model further enhances this process by enabling students to prepare beforehand and utilize classroom time for higher-order cognitive tasks facilitated by competitive or cooperative game dynamics.

3. Research Objective, Questions, and Hypotheses

This study aims to explore and compare the effects of competitive and cooperative gamification mechanics in a flipped classroom setting on the enhancement of learning performance, specifically its cognitive and skills aspects, of female first-year middle school students enrolled in a digital technology course. The study examines the impacts of both competitive and cooperative gamification mechanics on students' learning outcomes and aims to determine which approach is more effective in enhancing students' cognitive and skills development. Several research questions and hypotheses were formulated to address the research goals (Table 1).

Table 1. Research questions and associated hypotheses.

Research Questions	Research Hypotheses
RQ1: What is the impact of the competitive gamification mechanic in a flipped classroom on students' learning performance (cognitive and skills)?	H1.1: The competitive gamification mechanic has a statistically significant effect on the development of the cognitive aspect of learning performance in pre- and post-achievement test scores.
	H1.2: The competitive gamification mechanic has a statistically significant effect on the development of the skills aspect of learning performance in pre- and post-observation card scores.
RQ2: What is the impact of the cooperative gamification mechanic in a flipped classroom on students' learning performance (cognitive and skills)?	H2.1: The cooperative gamification mechanic has a statistically significant effect on the development of the cognitive aspect in pre- and post-achievement test scores.
	H2.2: The cooperative gamification mechanic has a statistically significant effect on the development of the skills aspect in pre- and post-observation card scores.
RQ3: What is the difference between the cooperative and competitive gamification mechanics in influencing students' learning performance (cognitive and skills)?	H3.1: There is a statistical difference in the effect between the competitive and cooperative gamification mechanics on the development of the cognitive aspect in achievement test scores.
	H3.2: There is a statistical difference in the effect between the competitive and cooperative gamification mechanics on the development of the cognitive aspect in observation card scores.

4. Methodology and Experimental Design

The study employed a quasi-experimental design based on pre- and post-test measurements for the two experimental groups. The first experimental group was taught using a competitive gamification mechanic within a flipped classroom model. In contrast, the second experimental group was taught using a cooperative gamification mechanic within a flipped classroom model. Figure 1 illustrates the quasi-experimental design of the study.

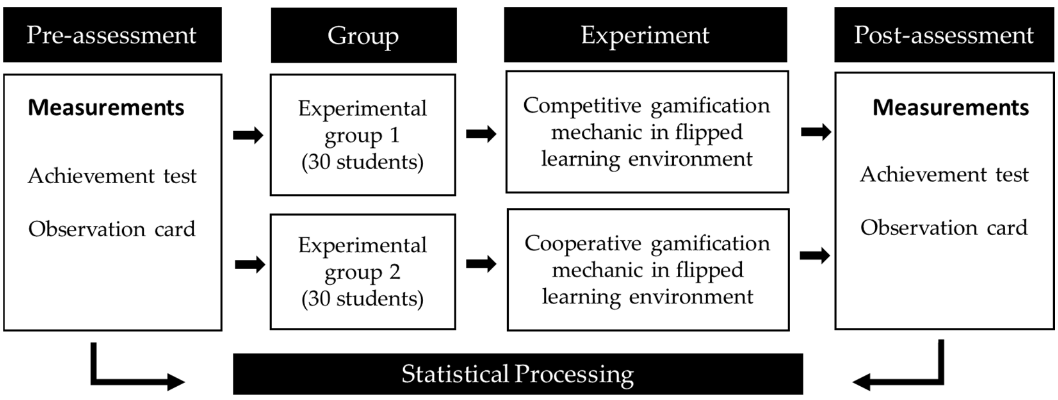

Figure 1. Experimental design of the study.

4.1. Sample

The participants consisted of 60 female first-year middle school students aged 13 years old from a governmental school, selected using a simple random sampling method. The students were then randomly divided into two experimental groups of 30 students each. The first group was taught using competitive digital gamification mechanics within a flipped classroom environment, while the second group was taught using cooperative digital gamification mechanics within the same environment. The students have already acquired basic computer knowledge and skills from previous learning topics, which serve as the foundation for their study of the new topic. The intervention was designed to align with their existing knowledge and skills, introducing gamified learning methods in a manner accessible to their level of digital literacy. The intervention began with an introductory session that acquainted students with the digital gamification platform. This session included step-by-step guidance on how to access learning materials, navigate the platform, and participate in both competitive and cooperative gamification activities. Additionally, we initially assigned simple tasks to ensure students were comfortable with the tools and processes before progressing to more complex gamified tasks.

4.2. Instructional Design of the Gamification Mechanic (Competitive/Cooperative)

To achieve the study's objectives, the analysis, design, development, implementation, and evaluation (ADDIE) instructional design model [34] was used to design and produce the experimental treatment material, which consisted of gamification mechanics (competitive/cooperative) in a flipped classroom environment. The following section discusses the five stages of the ADDIE model.

4.2.1. Analysis

The analysis stage is a critical first step in the instructional design process and serves as the foundation for subsequent stages [34]. This stage starts with defining the learning topic in the digital technology course. The first unit, Internet and communication, was chosen; it consisted of four lessons. This was followed by identifying learner characteristics. The participants had similar characteristics, including having some prior knowledge of digital skills from their elementary education. The analysis ensured that the students had the necessary resources (such as access to computers and the Internet) to participate effectively in the digital learning environment.

Then, drawing on the teacher's guide and the curriculum objectives, the core learning tasks related to this unit were analyzed and broken down into specific tasks. These tasks were then reviewed and refined with input from experts, resulting in a final set of four main tasks and 60 sub-tasks (shown in Figure 2). The general objectives of the study were also established, focusing on enhancing students' digital competencies. Finally, various resources were evaluated, including spatial resources (school labs and home environments), temporal resources (blending in-class and at-home learning), and technological resources (computers and Internet access).

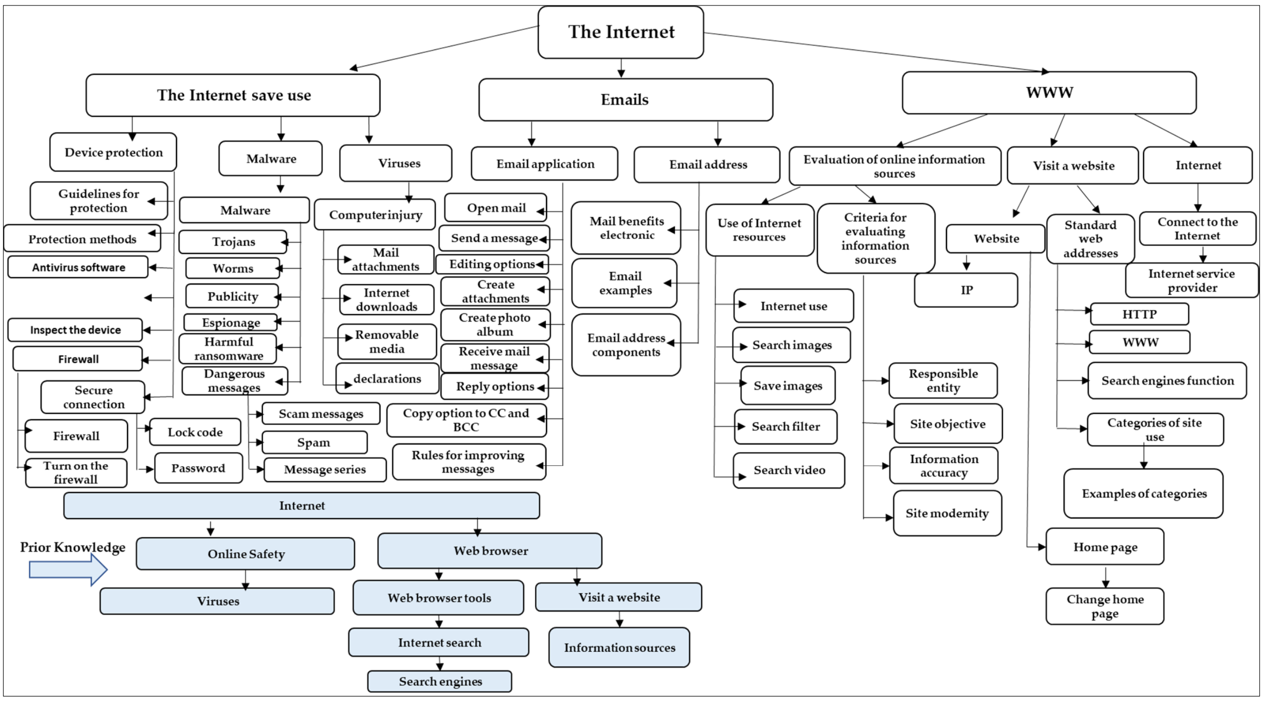

Figure 2. Analysis of the unit learning tasks.

4.2.2. Design

According to Peterson [34], the design stage included setting behavioral objectives, which were defined based on the general goals established earlier. The researcher relied on the teacher's guide provided by the Ministry of Education to draft the initial list of digital competencies [35]. The objectives were reviewed and refined with input from experts in curriculum and instructional technology to ensure their accuracy and relevance. The educational content was then designed in alignment with the previously defined objectives, ensuring that it was appropriate for the student's age group and scientifically and linguistically accurate. The content was then organized into tables that matched the various lessons with their corresponding objectives. The learning time was set according to the school's schedule, with each lesson designed to fit within two 45-min sessions.

The next step was to select a learning management system (LMS) that was appropriate for the design of the gamification/flipped learning environment. After extensive research and testing of various applications, TalentLMS (version 4.8) was chosen for its ability to incorporate gamification elements that aligned with the study's needs as well as its compliance with e-learning quality standards, open-source availability, and full Arabic language support. Various tools and software were then employed to create and refine the content, including Adobe Photoshop (version 26), Canva (version 1.97), and iMovie (version 10.4).

The lessons and activities were structured as challenges, with each challenge containing several tasks. The design employed Gagné et al.'s [36] model of instruction, a framework that ensures that each lesson will effectively engage students and support their learning. Next, several gamification elements were designed to be integrated into TalentLMS, including avatars, points, badges, progress bars, rewards, levels, certificates, rules, tasks, immediate feedback, relationships, freedom to fail, and content locking. These elements were chosen to enhance engagement and motivate students. The challenges were then designed to include a set of tasks divided into homework and classroom tasks. All the tasks were organized and structured sequentially, allowing the students to complete them step by step, following a linear navigation pattern. Homework tasks (such as lesson content) were completed at home, while classroom tasks (such as cognitive and skill-based activities) were addressed in the classroom. The organization is illustrated in Table 2.

Table 2. Task organization.

Learning Setting	Task Organization
Out-of-class learning	Game Rules—For the First Challenge First Task—Introduction What Will I Learn? Lesson Content Enrichment—To Learn More Homework Task
In-class learning	Introduction to the Classroom Task Cognitive Task Skill-Based Task

The flipped learning environment incorporated multiple methods of interaction, enabling students to engage with the learning platform, collaborate with their peers, and communicate with the teacher. These interactions were supported by TalentLMS features, including tools like chat, discussion rooms, and private messaging, which facilitated seamless communication and collaboration. The final step involved creating a detailed scenario for the learning environment, which included a comprehensive description of the user interfaces, their layout, and functionality. This scenario outlined how students would navigate the platform, access learning materials, and interact with its tools. It also detailed the flow of activities within the environment, specifying how users would transition between tasks and participate in collaborative exercises individually and collaboratively. The scenario was then reviewed and validated by experts in educational technology.

4.2.3. Development

During the development stage, the focus was on transforming the design specifications into tangible educational elements. This stage involved several key processes, starting with multimedia production [34]. Texts were formatted, compiled, and edited using Microsoft Word, ensuring linguistic accuracy. Static images were sourced from Google and then processed and edited using Adobe Photoshop. Educational content videos were created for students using TalentLMS. The videos were sourced from YouTube and edited using iMovie and Microsoft Clipchamp (version 2.3.5), with each video not exceeding 8 min in duration. The next step was the creation of gamification mechanics (competitive/cooperative) in a flipped classroom environment. The experimental environment was carefully designed to incorporate these mechanics into TalentLMS. The lessons were structured as challenges, with each challenge containing a set of tasks. The tasks were consistent across the competitive and cooperative groups, with differences in the application mechanics for tasks requiring competition or collaboration. Each challenge was tailored to the specific needs of either the competitive or cooperative group. The implementation mechanic is illustrated in Table 3.

Table 3. Gamification mechanic implementation process.

Gamification Mechanic	Location	Implementation Process
Competitive	Home	Students completed all the tasks step by step, individually.
	Classroom	Students continued to work individually with TalentLMS in the classroom. The Kahoot learning environment was also integrated with TalentLMS so that students could complete cognitive tasks in a competitive, individual manner.
Cooperative	Home	Learning took place in small groups of five students, with each group assigned a specific name. Within each group, students collaborated on tasks step by step, discussing and deliberating with their group members before completing any task and continuing until all the tasks were finished. This approach was facilitated through dedicated discussion rooms for each group, where they could discuss both home and classroom tasks. Students could identify their group through the 'My Groups' tab.
	Classroom	Collaborative work continued in the classroom, both directly and through TalentLMS. The Kahoot learning environment was also integrated with TalentLMS so that students could complete cognitive tasks collaboratively within groups while competing against other groups.

Classroom tasks were securely locked within the electronic learning environment, with access restricted until the designated class time. To unlock these tasks, the teacher provided a password during the session, ensuring that students could only proceed under the teacher's guidance. This controlled access not only maintained a structured progression of tasks but also promoted a focused and synchronized learning experience for all participants. Following this, the gamification mechanics were carefully designed to incorporate both competitive and cooperative elements. These mechanics were tailored to foster engagement, with competitive features encouraging individual achievement and cooperative features promoting teamwork and collaboration. Figure 3 illustrates the gamification elements designed for this study.

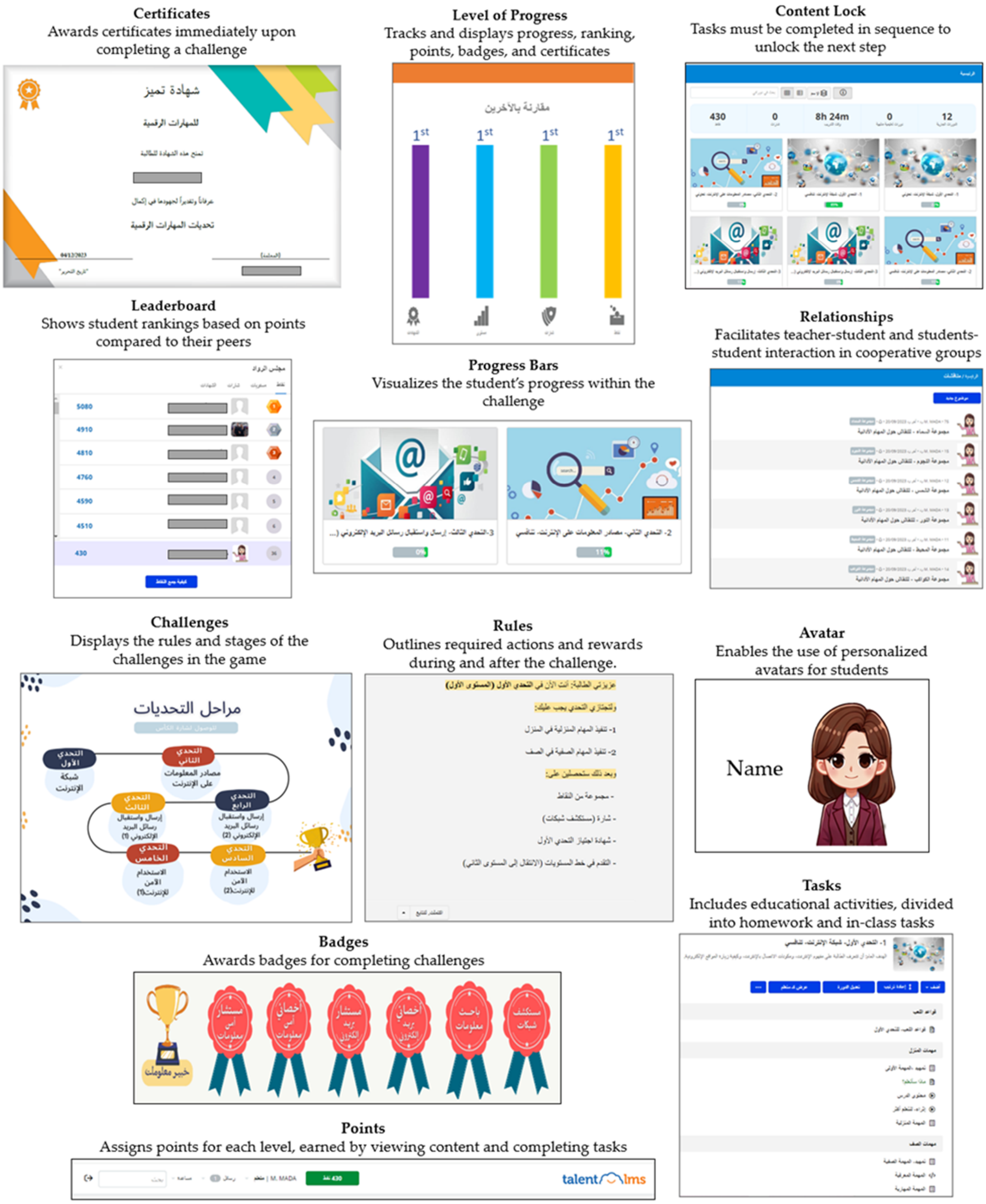

Figure 3. Gamification elements used in this study.

All tasks and learning activities were designed using TalentLMS, leveraging the authoring tools available within the system to serve the educational content's objectives and assess their achievement. For the cognitive task, the Kahoot (version 4) learning environment was used to increase excitement and enthusiasm in the classroom, as it provides digital gamification elements that align with the current study's objectives. Kahoot supports educational activities in both competitive and cooperative ways. The Kahoot environment was also integrated with TalentLMS. All tasks were designed to allow multiple attempts, thereby reinforcing mastery of the material. Figure 4 shows a sample of the learning activities designed for the study.

Competitive Gamification Mechanic

Cooperative Gamification Mechanic

Figure 4. Sample learning activities.

After the gamification mechanics in a flipped learning environment were developed, they were reviewed by experts in educational technology and computer science. Their feedback was used to make adjustments, ensuring that the environment was pedagogically sound and technically functional. The final design was then implemented and made available to students at www.mada.talentlms.com, accessed on 20 August 2023.

4.2.4. Implementation

The implementation stage was divided into two primary procedures. First, a pilot version of the learning environment that had been developed was tested on a small, exploratory sample of seven students outside the main study sample. This phase aimed to assess the clarity of the educational content, the suitability of the environment for the student's level, and the feasibility of executing the learning environment as planned, as well as to identify any potential difficulties or problems during implementation [34]. The pilot study revealed that although the content and skills presented in the learning environment developed for the study were clear and appropriate for the students, training sessions should be conducted with the main study sample before the actual experiment to familiarize them with the learning environment (including how to interact with the environment) and the main communication tools they would use. The primary implementation of the experiment then took place. This implementation is discussed in more detail in Section 4.4.

4.2.5. Evaluation

Finally, the evaluation stage included both formative and summative evaluations [34]. As previously mentioned, formative evaluation was conducted continuously throughout all stages. This step involved refining and improving the learning environment before its actual use. The pilot testing of the environment, as detailed in the implementation stage, served as a critical component of the formative evaluation since it allowed adjustments and enhancements before the full implementation occurred. The summative evaluation was conducted through post-application of the study tools.

4.3. Measurements and Their Validity and Reliability

4.3.1. Achievement Test

The primary purpose of this achievement test was to evaluate the cognitive knowledge related to digital competencies among first-year middle school students. The focus was on understanding how well students grasped the cognitive knowledge taught in their gamified flipped classroom, thus enabling a comparison of their performance pre- and post-intervention. The test items were developed based on the specific educational objectives associated with the intended unit content. The test consisted of 30 multiple-choice questions, each offering four possible answers. Each question was crafted to focus on a single idea or concept, which ensured clarity and precision.

The test's content validity was established through the creation of a table of specifications, ensuring that the test items represented a comprehensive and relevant sample of the unit content. This process involved matching the test items to the educational objectives to confirm that the test covered all the necessary areas of the digital skills curriculum. Expert validation was sought to confirm the appropriateness of the test items. The initial version of the test was reviewed by a panel of experts in educational technology and curriculum design. These experts evaluated the test for its relevance to the skills and objectives, the clarity of the language used, and the scientific accuracy of the content. Based on their feedback, adjustments were made to improve the clarity and precision of the test items, ensuring that the test was well aligned with its intended purpose.

To measure its statistical validity and reliability, the test was piloted with a sample of 30 students from a different school to ensure that the test items functioned as intended. To verify the internal consistency validity of the test, Pearson correlation coefficients were calculated to measure the relationship between each question and the total score of its respective domain, excluding the item being analyzed from the total score to avoid artificially inflating the correlation. Correlations were also calculated between each domain and the overall test score. All coefficients were positive, statistically significant at the 0.01 level, and exceeded the recommended threshold of 0.3 [37], indicating strong internal consistency. The item-total correlation coefficients ranged from 0.704 to 0.920. Based on these results, no items were removed from the scale. This finding indicated that all the test questions were valid and measured the intended objective. Cronbach's alpha internal consistency was used to measure the reliability of the test tool. The overall Cronbach's alpha for the test was 0.913, which is considered high, indicating that the test was reliable and consistently measured the cognitive outcomes it was designed to assess.

4.3.2. Observation Card

The observation card was developed to assess practical skills related to digital competencies among first-year middle school students. It was used to evaluate the students' hands-on abilities and how well they could apply the digital skills they had learned in real-life scenarios. The card was built around four core digital skills areas: Internet use, Internet resource use, email management, and online safety. These areas were identified as critical components of the practical aspect of digital skills. Each core skill was further broken down into sub-skills, resulting in a total of 20 specific skills to be assessed. For example, the skill of using the Internet might include sub-skills such as navigating websites or using search engines effectively.

Each item on the card was carefully worded to ensure that it described a single observable behavior or skill. The language was kept clear and specific to make it easy for observers to consistently evaluate each student's performance. A three-point rating scale was used to quantify the students' performance. The scale ranged from 'performed without help' (2 points) to 'performed with help' (1 point) to 'did not perform' (0 points). This scoring system allowed for a nuanced assessment of each student's skill level and provided a clear metric for evaluating their performance.

To ensure content validity, the observation card underwent an expert review. Their feedback led to revisions that then improved the checklist's precision and ensured that each item accurately measured the intended skill. The internal consistency validity of the card was verified by applying it to a pilot group of 30 students. Pearson correlation coefficients were calculated for each item relative to the overall score for its respective skill area and each skill area relative to the total card score. The high correlation values (significant at the 0.01 level) indicated that the items within each skill area were consistent and measured the same underlying construct.

The reliability of the observation card was measured using Cronbach's alpha for each skill area and the card as a whole. The alpha values ranged from 0.734 to 0.938, with the overall reliability of the card being 0.936. These high values indicated that the card was highly reliable and provided consistent results across different observations. To further ensure the reliability of the card, inter-rater reliability was tested by having multiple observers evaluate the same set of students. Agreement between observers was calculated using Cooper's formula, with agreement rates ranging from 84.5% to 90%. The overall agreement rate of 86% confirmed that the card provided reliable measurements across different evaluators, thus reducing the likelihood of subjective bias in the assessments.

4.4. Data Collection and Analysis

The data collection process in this study was carefully structured to ensure the reliability and validity of the findings. The study was conducted during the first semester of the 2023 academic year following the acquisition of the necessary ethical approval and other relevant educational authorities. Subsequently, the researcher ensured the readiness of the computer labs at the school, the functionality of the equipment, and the availability of the necessary study requirements. A sample of 60 first-year middle school students was selected and divided into two experimental groups according to the study procedures: 30 students for the competitive gamification mechanic group and 30 students for the cooperative gamification mechanic group.

Meetings were held with the study groups of first-year middle school students to introduce them to the nature of the gamified flipped model and to demonstrate how to interact and communicate with the learning environment. Communication through WhatsApp was also used for additional support and organization regarding the program. The students in the cooperative gamified mechanic group were further divided into smaller groups of five students, with a name assigned to each group. Both study groups were instructed on how to access the learning environment from their computers and mobile devices through TalentLMS (which operates on both the Android and iOS platforms); they could use TalentLMS at any time and from any convenient location following the schedule announced on the TalentLMS website. Students were then allowed to register in the learning environment, with their progress monitored and assistance provided to those who encountered difficulties. Each student was allocated a portable device in the school's lab, ensuring that they had access to the Internet.

The primary experiment took place over approximately four weeks. It began with the administration of pre-study tools (the achievement test and observation card) to verify the homogeneity of the two groups. The primary intervention was then implemented. After the intervention, post-tests were administered to both groups to evaluate the intervention's impact on students' learning performance.

The data analysis was conducted using the Statistical Package for the Social Sciences (SPSS), version 25. Descriptive statistics, such as the mean (*M*) and standard deviation (*SD*), were used to summarize the data and provide an overview of the participants' performance. An independent samples t-test was used to compare the mean scores of the two groups and assess the significance (at the 0.05 level) of any differences observed in their pre-test and post-test results. Dependent samples t-testing was used to assess within-group differences between pre- and post-test scores.

5. Results

Table 4 presents the results of the sample homogeneity test, which was conducted to assess the baseline equivalence of the two experimental groups (Competitive and Cooperative) using pre-test scores from the achievement test and observational card. The results indicate no statistically significant differences between the groups, demonstrating that their performance was equivalent prior to the intervention. These findings ensure that any observed differences in post-test results can be attributed to the gamification mechanics rather than pre-existing disparities between the groups. In regard to the mean scores, no external benchmark was applied; the mean scores reflect participants' initial performance levels, validating the internal validity of the quasi-experimental design. Likewise, the following Tables 5–7 report mean scores derived from validated assessment instruments tailored to the study's objectives. The achievement test measured cognitive understanding, while the observation card evaluated practical skills. No external benchmark was applied, as the study focused on relative group performance and improvement within the context of the intervention. This approach aligns with best practices in educational research methodology, emphasizing the importance of baseline comparability to establish causal inferences in intervention studies [38].

Table 4. Sample homogeneity test.

Measurement	Competitive		Cooperative		*t*-Value	*df*	*p*-Value
	M	*SD*	*M*	*SD*			
Achievement test	6.27	1.99	6.40	2.03	−0.25	58	0.79
Observational card	7.13	2.66	7.33	2.09	−0.32	58	0.74

Table 5. Paired-sample *t*-test results for the competitive gamification mechanic.

Group	Pre-Test		Post-Test		*t*-Value	*df*	*p*-Value	Cohen's *d*
	M	*SD*	*M*	*SD*				
Achievement text (cognitive aspect)	6.27	1.99	27.53	2.53	−38.616	29	$p < 0.001$	7.05
Observational card (skills aspect)	7.13	2.66	38.93	1.33	−64.299	29	$p < 0.001$	11.73

Table 6. Paired-sample *t*-test results for the cooperative gamification mechanic.

Group	Pre-Test		Post-Test		*t*-Value	*df*	*p*-Value	Cohen's *d*
	M	*SD*	*M*	*SD*				
Achievement text (cognitive aspect)	6.40	2.02	27.57	1.90	−41.514	29	$p < 0.001$	7.57
Observational card (skills aspect)	7.33	2.09	39.07	1.02	−70.182	29	$p < 0.001$	12.81

Table 7. Independent-sample *t*-test results for measuring the difference between the groups.

Measurement	Competitive		Cooperative		*t*-Value	*df*	*p*-Value	Cohen's *d*
	M	*SD*	*M*	*SD*				
Achievement text (cognitive aspect)	27.53	2.52	27.57	1.91	−0.058	58	0.954	0.02
Observational card (skills aspect)	38.93	1.33	39.06	1.02	−0.435	58	0.665	0.11

The findings are discussed below in this study's three research questions.

- RQ1: What is the impact of the competitive gamification mechanic in a flipped classroom on students' learning performance (cognitive and skills)?

  Two hypotheses were proposed to answer this question:

- H1.1: The competitive gamification mechanic has a statistically significant effect on the development of the cognitive aspect of learning performance in pre- and post-achievement test scores.

- H1.2: The competitive gamification mechanic has a statistically significant effect on the development of the skills aspect of learning performance in pre- and post-observation card scores.

The results in Table 5 indicate a significant increase in both the cognitive and skills aspects following the implementation of the competitive gamification mechanic. The paired-sample t-test results show that for the cognitive aspect, the mean score increased from 6.27 (SD = 1.99) in the pre-test to 27.53 (SD = 2.53) in the post-test, with a t-value of −38.616, and the result was statistically significant ($p < 0.001$). Similarly, for the skills aspect, the mean score improved from 7.13 (SD = 2.66) in the pre-test to 38.93 (SD = 1.33) in the post-test, with a t-value of −64.299, which was also statistically significant ($p < 0.001$). These findings support both hypotheses, demonstrating the positive impact of competitive gamification on students' learning performance.

In addition, Table 5 demonstrates significant improvements in both cognitive and skills aspects of students' performance. For the cognitive aspect, mean scores increased from 6.27 (SD = 1.99) to 27.53 (SD = 2.53), with $p < 0.001$, and Cohen's d = 7.05, indicating an extremely large effect [39]. Similarly, for the skills aspect, mean scores rose from 7.13 (SD = 2.66) to 38.93 (SD = 1.33), with $p < 0.001$, and Cohen's d = 11.73, also reflecting an extremely large effect. According to Cohen [39], these effect sizes far exceed the thresholds for small (d = 0.2), medium (d = 0.5), and large effects (d = 0.8). These findings suggest not only statistical significance but also practical meaningfulness, demonstrating a profound impact of the competitive gamification on students' cognitive and practical performance.

- RQ2: What is the impact of the cooperative gamification mechanic in a flipped classroom on students' learning performance (cognitive and skills)?

  Two hypotheses were proposed to answer this question:

- H2.1: The cooperative gamification mechanic has a statistically significant effect on the development of the cognitive aspect in pre- and post-achievement test scores.
- H2.2: The cooperative gamification mechanic has a statistically significant effect on the development of the skills aspect in pre- and post-observation card scores.

The paired-sample t-test results indicate that the cooperative gamification mechanic also led to significant improvements (Table 6). For the cognitive aspect, the mean score increased from 6.40 (SD = 2.02) in the pre-test to 27.57 (SD = 1.90) in the post-test, with a t-value of −41.514, and the result was statistically significant ($p < 0.001$). Regarding the skills aspect, the mean score rose from 7.33 (SD = 2.09) in the pre-test to 39.07 (SD = 1.02) in the post-test, with a t-value of −70.182, which was also statistically significant ($p < 0.001$). These results confirm the hypotheses, demonstrating that cooperative gamification positively influenced the students' cognitive and skills development.

In regard to the effect size, Table 6 demonstrates significant improvements in both cognitive and skills aspects of students' performance under the cooperative gamification mechanic. For the cognitive aspect, mean scores increased from 6.40 (SD = 2.02) to 27.57 (SD = 1.90), with $p < 0.001$ and Cohen's d = 7.57, indicating an extremely large effect [39]. Similarly, for the skills aspect, mean scores rose from 7.33 (SD = 2.09) to 39.07 (SD = 1.02), with $p < 0.001$ and Cohen's d = 12.81, also reflecting an extremely large effect. These findings suggest not only statistical significance but also practical importance, demonstrating a profound impact of the cooperative gamification mechanic on students' cognitive and practical performance.

- RQ3: What is the difference between the cooperative and competitive gamification mechanics in influencing students' learning performance (cognitive and skills)?

  Two hypotheses were proposed to answer this question:

- H3.1: There is a statistical difference in the effect between the competitive and cooperative gamification mechanics on the development of the cognitive aspect in achievement test scores.

- H3.2: There is a statistical difference in the effect between the competitive and cooperative gamification mechanics on the development of the cognitive aspect in observation card scores.

The independent-sample *t*-test results reveal minimal differences between the two gamification mechanics (Table 7). For the cognitive aspect, the mean scores were 27.53 (*SD* = 2.52) for the competitive group and 27.57 (*SD* = 1.91) for the cooperative group, with a *t*-value of −0.058, and this result was not statistically significant (p = 0.954). Likewise, for the skills aspect, the mean scores were 38.93 (*SD* = 1.33) for the competitive group and 39.06 (*SD* = 1.02) for the cooperative group, with a *t*-value of −0.435, and this result was not statistically significant (p = 0.665). These findings suggest that while both gamification mechanics significantly enhanced students' learning performance, the differences between the mechanics in their effects on cognitive and skills development were not substantial, though the competitive mechanic showed slightly lower variability in both cognitive and skills scores.

In Table 7, for the cognitive aspect, the Cohen's d = 0.02, indicating a negligible effect size [39]. Similarly, for the skills aspect, Cohen's d = 0.11, reflecting a small effect size. These findings suggest no statistically significant or practically meaningful differences between the two gamification mechanics, indicating that both approaches have similar impacts on students' cognitive and practical performance.

6. Discussion and Implications

The results reveal that both the competitive and cooperative gamification mechanics significantly enhanced students' learning performance, as evidenced by the marked improvements in post-test scores compared to pre-test scores in both cognitive achievement and skill development.

The increase in cognitive achievement and skill acquisition across both gamification mechanics may be attributed to the carefully designed digital learning environment, which was grounded in established educational frameworks, such as the ADDIE model. The structured and well-balanced integration of gamification elements within this environment provided a motivating and engaging platform for students, thus aligning with previous studies, such as those of Sanchez et al. [25], Ng and Lo [26], and Zhang [31]. These studies also found that gamified learning environments in flipped classrooms led to improved learning outcomes and increased student engagement. The success of both gamification mechanics in this study may also be partly attributed to the well-designed digital learning environment provided by TalentLMS. This platform facilitated a flexible, accessible, and supportive learning environment, allowing students to engage in self-paced learning, repeat tasks until they had achieved mastery, and receive immediate feedback—factors that are critical in supporting effective learning. The incorporation of elements such as badges, leaderboards, and progress tracking also played a significant role in maintaining student motivation and engagement [40].

Interestingly, the comparative analysis between the competitive and cooperative gamification mechanics revealed no statistically significant differences in the mechanics' effects on learning outcomes, aligning with the findings of Morschheuser et al. [12], Al-Tabbakh and Ismail [16], and Ammar [8]. The lack of statistically significant differences between competitive and cooperative gamification mechanics in this study is intriguing and suggests the need for a deeper examination of potential explanations. One reasonable explanation is the well-balanced design of the gamified elements within the TalentLMS platform, which may have equalized the engagement and motivation levels of students across both mechanics. The platform incorporated key gamification features, such as progress tracking, immediate feedback, and a clear system of rewards, which are essential elements that contribute to the learning experience. By ensuring that both competitive and cooperative groups experienced these elements similarly, the motivational impact of the gamification mechanics was likely balanced, reducing the potential for one to outperform the other in terms of learning outcomes. Moreover, the structure of the flipped classroom model may have contributed to minimizing the potential differences between the two gamification mechanics. In a flipped classroom, students engage with learning materials both individually before class and collaboratively during class [4]. This hybrid approach likely created an environment in which students were able to benefit from both competitive and cooperative aspects, regardless of the gamification mechanic employed. For example, pre-class preparation through videos and readings promoted individual responsibility, while in-class activities facilitated collaboration and interaction, effectively blending both approaches. This could explain why neither competitive nor cooperative mechanics demonstrated a distinct advantage in enhancing students' cognitive or skill development.

Research suggests that the integration of gamification mechanics into flipped classrooms enhances their effectiveness by aligning active learning opportunities with motivational elements. For instance, gamification can complement flipped pedagogy by providing immediate feedback, fostering friendly competition or collaboration, and scaffolding complex tasks into manageable challenges [41,42]. These benefits may explain the significant improvement in both cognitive achievement and skill development observed in our study, as both competitive and cooperative mechanics actively engage students in their learning processes. However, it is important to note that flipped classrooms inherently differ from traditional teaching models in their structure and reliance on technology to facilitate pre-class preparation and in-class activities. As such, the results observed in this study may not be directly transferable to other teaching models without further investigation. Future research could explore whether gamification mechanics produce similar results in traditional settings or whether their effectiveness is amplified specifically within the flipped classroom environment.

Additionally, it is important to consider the influence of student characteristics and learning environments on the outcomes. It is possible that the student population in this study, particularly their familiarity with technology and previous exposure to gamification in learning, may have played a role in diminishing the differences between the two approaches. If students were already accustomed to gamified learning environments, their responses to both competitive and cooperative mechanics might have been more balanced, with neither mechanic being perceived as novel or particularly motivating. This could be an avenue for further research, as understanding how prior experience with gamified learning influences the effectiveness of different mechanics may provide additional insights into the results. Lastly, it may be that the specific subject matter and content used in the flipped classroom, as well as the nature of the assessments, played a role in producing similar outcomes across the two groups. Certain types of content or skills may not lend themselves to a clear distinction between competitive and cooperative learning, particularly when both types of gamifications are well designed and effectively integrated into the learning process. Further research is needed to explore whether different content areas or skill types can produce different outcomes when competitive and cooperative mechanics are applied.

Given the positive outcomes observed in this study, the results indicate that educators should be more flexible in their instructional designs. They may choose the mechanic that best aligns with their teaching style, classroom dynamics, or specific learning objectives without worrying about sacrificing effectiveness. This flexibility is particularly valuable in diverse classrooms, where students may have different preferences or respond differently to various teaching strategies. Although the study found no significant difference overall, its results do not rule out the possibility that certain contexts or specific student groups might benefit more from one mechanic over the other. Educators could use this insight to tailor their approach based on the specific needs of their students or the subject matter being taught. For instance, in highly competitive environments or with subjects that naturally lend themselves to competition, such as sports or debate, a competitive gamification approach might be more motivating. Conversely, in subjects that require collaboration and teamwork, such as group projects or lab work, a cooperative approach might be more effective. Similarly, individual students' preferences for competition or collaboration should not be overlooked. Some students may naturally thrive in competitive environments, while others might feel more comfortable and perform better in cooperative settings. Educators might consider providing students with options or incorporating both mechanics within a single course to cater to different learning styles and preferences.

The similar effectiveness of both mechanics suggests the potential for hybrid approaches that combine elements of both competition and cooperation. For instance, a course could include competitive elements within cooperative groups where students work together in teams but also compete against other teams. This method could maximize the benefits of both approaches, thereby fostering collaboration within groups while harnessing the motivational power of competition. At a broader level, the study's findings could inform educational policy and curriculum design by highlighting the importance of flexibility and adaptability in teaching strategies. Policymakers and curriculum designers might consider integrating a range of gamification techniques into educational programs, which would allow for differentiation and personalization in the learning process.

7. Conclusions, Limitations, and Future Perspectives

This study explored the impact of competitive and cooperative gamification mechanics within a flipped classroom model on students' cognitive achievement and skill development. Both gamification approaches significantly enhanced the students' learning outcomes, with no statistically significant difference between the two approaches in terms of their effectiveness. This finding suggests that both competitive and cooperative gamification mechanics are equally viable strategies for improving student engagement and performance in digital learning environments.

Although this study provides valuable insights, it is important to recognize several limitations. First, while our study focuses on comparing the effects of competitive and cooperative gamification mechanics within flipped classrooms, a traditional teaching group would have allowed for broader comparisons across pedagogical approaches. To address this limitation, we propose that future research include a control group employing traditional teaching methods to better understand the unique contributions of flipped classrooms and gamification mechanics to learning outcomes. Such a design could help determine whether the observed improvements in cognitive achievement and skills are exclusive to flipped classrooms or applicable across different teaching environments. Second, the study was conducted with a specific group of students, which may limit the generalizability of the findings to other populations. A larger and more diverse sample would provide a broader understanding of how competitive and cooperative gamification mechanics affect different student groups. Third, the study primarily measured the immediate effects of gamification on cognitive and skill development. Longitudinal research is needed to assess the long-term impact of these mechanics on student motivation, knowledge retention, and overall academic performance. Fourth, the study was conducted within the context of a flipped classroom model using the TalentLMS platform. While this environment provided a controlled setting for examining the effects of gamification, the results may not be directly applicable to other educational settings or platforms. Further research is needed to explore the impact of gamification on different instructional models and technological environments. Fifth, this study primarily adopts a quantitative approach to evaluate the effects of gamification mechanics on learning outcomes, focusing on objective measures such as cognitive and skills-based achievement. While this provides robust evidence of the intervention's effectiveness, we acknowledge the value of integrating students' feedback and reflections to gain deeper insights into their awareness, motivation, and engagement with gamification mechanics. Future research could adopt a mixed-methods approach to explore these qualitative dimensions, complementing quantitative findings and offering a more comprehensive understanding of how students perceive and interact with gamified learning environments.

Given the similar effectiveness of the competitive and cooperative mechanics found in this study, future research could explore hybrid gamification approaches that combine elements of both competition and cooperation. Studies could investigate whether such hybrid models offer additional benefits or enhance learning outcomes by leveraging the strengths of both mechanics. Future research could also explore how the customization and personalization of gamified learning experiences—tailoring gamification elements to individual student preferences and needs—affect learning outcomes. Such research could involve the development of adaptive gamification systems that adjust the level of competition or cooperation based on real-time data about student performance and engagement.

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